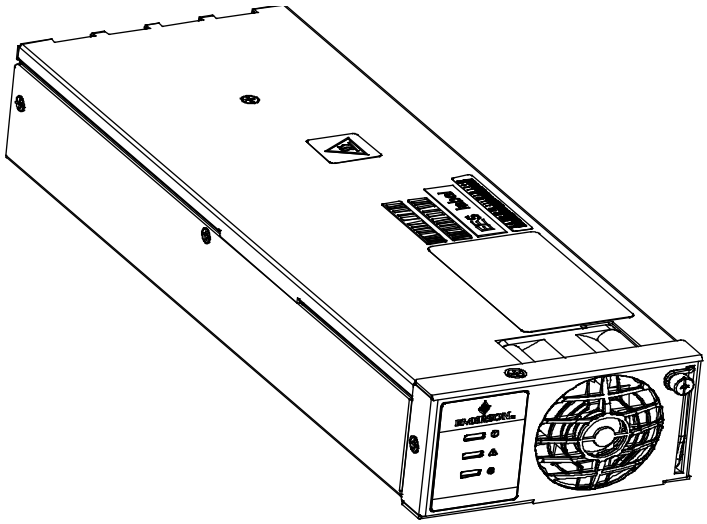
# NetSure™ DC/DC Converter Module

User Manual, UM1C48241500 (Issue AC, January 27, 2014)

Specification Number: 1C48241500
Model Number: C48/24-1500



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## Admonishments Used in this Document

| | |
|---|---|
| | **DANGER!** Warns of a hazard the reader ***will*** be exposed to that will ***likely*** result in death or serious injury if not avoided. (ANSI, OSHA) |
| | **WARNING!** Warns of a potential hazard the reader ***may*** be exposed to that ***could*** result in death or serious injury if not avoided. This admonition is not used for situations that pose a risk only to equipment, software, data, or service. (ANSI) |
| | **CAUTION!** Warns of a potential hazard the reader ***may*** be exposed to that ***could*** result in minor or moderate injury if not avoided. (ANSI, OSHA) This admonition is not used for situations that pose a risk only to equipment, data, or service, even if such use appears to be permitted in some of the applicable standards. (OSHA) |
| | **ALERT!** Alerts the reader to an action that ***must be avoided*** in order to protect equipment, software, data, or service. (ISO) |
| | **ALERT!** Alerts the reader to an action that ***must be performed*** in order to prevent equipment damage, software corruption, data loss, or service interruption. (ISO) |
| | **FIRE SAFETY!** Informs the reader of fire safety information, reminders, precautions, or policies, or of the locations of fire-fighting and fire-safety equipment. (ISO) |
| | **SAFETY!** Informs the reader of general safety information, reminders, precautions, or policies not related to a particular source of hazard or to fire safety. (ISO, ANSI, OSHA) |

## Static Warning

This equipment contains static sensitive components. The warnings listed below must be observed to prevent damage to these components. Disregarding any of these warnings may result in personal injury or damage to the equipment.

1. Strictly adhere to the procedures provided in this document.
2. Before touching any equipment containing static sensitive components, discharge all static electricity from yourself by wearing a wrist strap grounded through a one megohm resistor. Some wrist straps, such as Emerson Network Power Part Number 631810600, have a built-in one megohm resistor; no external resistor is necessary. Read and follow wrist strap manufacturer's instructions outlining use of a specific wrist strap.
3. Do not touch traces or components on equipment containing static sensitive components.
   Handle equipment containing static sensitive components only by the edges that do not have connector pads.
4. After removing equipment containing static sensitive components, place the equipment only on conductive or anti-static material such as conductive foam, conductive plastic, or aluminum foil. Do not use ordinary Styrofoam™ or ordinary plastic.
5. Store and ship equipment containing static sensitive components only in static shielding containers.
6. If necessary to repair equipment containing static sensitive components, wear an appropriately grounded wrist strap, work on a conductive surface, use a grounded soldering iron, and use grounded test equipment.

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# Introduction

## Overview

The C48/24-1500 is a compact DC/DC converter module which offers efficient power conversion. It operates from a nominal -48Vdc source to provide nominal +24Vdc load power.

## Specifications

### DC Output Ratings

- **Voltage:** Nominal +24 volts DC, negative ground. Output voltage is adjustable from 24 to 28 volts DC via the associated Controller.
- **Nameplate Rating:** 24 to 28 Vdc, 1500W.
- **Regulation:**
  a. **Output Voltage Tolerance:** < ±0.2% when the load is 50% and the temperature is from +15 to +35°C; < ±0.5% when the load is 50% and the temperature is from -5 to +55°C; < ±1% when the load is 50% and the temperature is from -20 to +55°C.
  b. **Temperature Regulation:** < ±0.02% when the load is 50% at -48Vdc and temperature range is from -10°C to +55°C.
  c. **Dynamic Response:** The dynamic response time at rated input and output voltage is ≤ 200us and overshot ≤ 5% for load changes at 50%-25%-50% and 50%-75%-50%.
  d. The output voltage is accurate at half load. At half load, the error of output voltage is ≤ ±100mV. Static regulation will give other voltage depending on load. The default value at half load is 27V.
- **Filtering:**
  a. Peak-peak voltage is ≤ 250mV at 1-100MHz and normal output voltage.
  b. Psophemetic noise voltage is ≤ 2mV between 5-100% of the maximum load (output voltage > 24V).
  c. Wideband noise is < 20mV rms between 25HZ-20kHz (test according to ETS300132).
  d. Output noise according to Telcordia GR-947-CORE: < 38 dBrnC (between 5-100% of the maximum load, output voltage > 24V).
- **Ripple Attenuation:** Ripple attenuation is better than +24dB, input to output and f < 360Hz.

### DC Input Ratings

- **Voltage:** Nominal -48 volts DC.
- **Nameplate Rating:** -41 to -58.5 Vdc, 39.5A max.
- **Inrush Current:** The peak value of the inrush current does not exceed 2 times the maximum steady-state peak value.
- **Input Regulation:** ≤ ±0.1% when the load is 100% at -42 to -58.5 Vdc input and temperature is +25°C.
- **Temperature Coefficient:** ≤ ±0.02%/°C over the specified operating temperature range.
- **Typical Input Data:** When equipped with one DC-DC converter module.
  a. See Table 1.
  b. **Maximum Current:** Input current is 39.5 amperes at -41.0 volts DC input and full load.

*Table 1. Typical Input Data*

| Input Voltage | Percent of Full Load | Input Current (Amps) | Efficiency (%) | Typical Heat Dissipation (BTU/Hr) |
|---|---|---|---|---|
| 42 VDC | 0 | 0.125 | -- | 18.02 |
| | 25 | 9.388 | 95.661 | 58.28 |
| | 50 | 18.803 | 95.416 | 122.84 |
| | 75 | 28.714 | 94.217 | 235.77 |
| | 100 | 38.888 | 92.835 | 394.06 |
| 48 VDC | 0 | 0.122 | -- | 20.02 |
| | 25 | 8.218 | 95.516 | 60.33 |
| | 50 | 16.431 | 95.336 | 125.12 |
| | 75 | 25.055 | 94.181 | 237.34 |
| | 100 | 33.887 | 92.800 | 396.04 |
| 58 VDC | 0 | 0.105 | -- | 20.93 |
| | 25 | 6.811 | 95.286 | 63.55 |
| | 50 | 13.601 | 95.141 | 130.57 |
| | 75 | 20.713 | 94.049 | 243.05 |
| | 100 | 27.987 | 92.689 | 402.69 |

***Note:*** *The output voltage of the DC-DC converter module is initially adjusted to 24 volts DC at 50% load and 48 volts DC input.*

### Environmental Ratings

- **Operation Temperature Range:** -40°C to +80°C (-40°F to +176°F), -20°C to +55°C (-4°F to +131°F) with full performance.

- **Storage Ambient Temperature Range:** -40°C to +70°C (-40°F to +158°F).
- **Humidity:** This converter module is capable of operating in an ambient relative humidity range of 0 to 90%, non-condensing.
- **Altitude:** The maximum operating ambient temperature should be derated by 3°C per 1000 feet at an elevation of 6,000 feet.
- **Ventilation Requirements:** The converter module is fan cooled and utilizes front to back forced ventilation.
- **Audible Noise:** With a single converter module installed and operating, the audible noise measured in front of converter at a 0.6m distance from a horizontal line from the middle of converter does not exceed 50 dBA with a temperature of 25°C.
- **Over Voltage Category:** II.
- **Power Distribution System:** TN/TT/IT.

*Note: The converter module is recommended to be used in an environment with Pollution of Degree 2 or less. Pollution Degree 2 applies where there is only non-conductive pollution that might temporarily become conductive due to occasional condensation (such as the office environment).*

**Compliance Information**

- **Safety Compliance:** This unit meets the requirements of UL 60950-1, Standard for Information Technology Equipment, and is UL Recognized as a power supply for use in Telephone, Electronic Data Processing or Information Processing Equipment.
- **EMC:** This unit meets EN300 386 V1.51, Class A, other than Telecom centers.
- **EFT:** This unit meets EN61000-4-4, EFT will be fulfilled for DC terminals at 4KV (CM) with criteria B and signal line at 1KV (CM) with criteria B.
- **ESD:** This unit meets EN61000-4-2; requirements are 6KV contact and 8KV air for criteria B and 8KV/15KV for criteria C.
- **Radiated Electrical Fields:** This unit meets EN61000-4-3. 10V/m in the frequency range 80MHZ-1GHz and 1.4-2GHz with criteria A will be fulfilled.
- **Power Frequency Magnetic Field:** This unit meets EN61000-4-8. 30A/m magnetic field at 50Hz will be fulfilled for criteria A.
- **Radiated Emission:** For electrical field, meets EN55022 Class A between 150KHZ-30MHZ. For a standalone converter the levels are 6db below the class A limits.
- **Climatic Environment:**
  a. **Transportation:** Meets ETS 300 019-1-2, Class 2.3.
  b. **Storage and Handling:** Meets ETS 300 019-1-1, Class 1.2.
  c. **Operation:** Meets ETS 300 019-1-3, Class3.2.
  d. **Transportation, Storage and Handling, Operation:** Meets Telcordia GR-63-Core, Chapter 4.

**Standard Features**

- **Type of Power Conversion Circuit:** High Frequency.
- **Input Voltage Protection:**
  a. **Fusing:** A non-user replaceable fuse is located in the positive input lead of each DC-DC converter module.
  b. **High and Low Input Voltage Inhibit:** The converter shuts down at low or high input voltage.
    1. **Low Voltage Disable Point:** -40.0 Vdc ±0.5 Vdc; hysteretic at least 3 Vdc for restart.
    2. **High Voltage Disable Point:** 59.5 Vdc ±0.5 Vdc; hysteretic at least 2 Vdc for start.
- **Output Protection:**
  a. **Overvoltage Protection:** When output voltage goes above a preset value (30.5±0.5V, not to exceed 31V for more than 150ms), the converter shuts down. Software settable HVSD level (from controller) 27V-30V.
  b. **Power Limit:** Output power is limited to 1500W.
  c. **Over Temperature Protection:** The operation of a DC-DC converter module will automatically shut down and lock out if the internal temperature of the module exceeds a predetermined value. Operation will automatically resume after the over-temperature condition is corrected.
- **Series Paralleling Output FET:** A series paralleling output FET is provided in each DC-DC converter module. This allows the Modules to be paralleled for redundancy.
- **Hot Swappable:** The converter module is designed to be plug-and-play. The converter module can be inserted or removed from a live DC power system with no damage. When the converter module is plugged into the system, the sub-system output voltage will not be affected.

- **Cooling:** Each converter module contains a fan for forced convection cooling.
  a. **Fan Fault Protection:** The converter module shuts down and its alarm indicator (red) flashes if the fan fails. Fan failure is detected and reported to controller. The fan is not field replaceable.
  b. **Fan Control:** Fan speed is continuously variable. When input voltage is within normal range, the built-in processor adjusts fan speed according to the converter module's output power. For example, a higher output power increases the fan speed.
- **Communication Failure:** The protection indicator (yellow) will flash should communication between the converter module and associated system Controller fail. The failure information will be reported to the associated system Controller and the Controller will process the failure accordingly. During a communication failure, the converter module output voltage will automatically adjust to 24.00Vdc. The converter module will revert to normal operation once normal communication is restored.
- **Monitoring Function:** The converter module has a built-in advanced DSP (Digital Signal Processor) that monitors and controls the operation of the converter module. The DSP also communicates with the associated system Controller in real time through the CAN bus. Table 2 lists the different commands and information exchanged between the converter module and the Controller.
- **External Alarm:** Provided via the associated Controller. Refer to the separate Power System documentation for a description of available external alarms.

Table 2. Monitoring Function

| Commands / signals that can be received by the Converter Module from the Controller. | Information gathered by the Controller from the Converter Module. |
|---|---|
| • Turn On/Off<br>• HVSD Reset<br>• Current Limit Adjustment<br>• Voltage Adjustment<br>• Fan Speed Control Enable/Disable<br>• HVSD Threshold | • Output Voltage<br>• Output Current<br>• Current Limit Setting<br>• Temperature<br>• Over Voltage Setting<br>• On/Off Status<br>• Fault Alarms, such as:<br>• HVSD<br>• Fan Fail<br>• EEPROM Failure<br>• Protection Alarms, such as:<br>• Input Voltage Protection<br>• High Temperature Protection<br>• Thermal Derating<br>• Address<br>• Code<br>• Date<br>• Software Version<br>• Hardware Version |

**Mechanical Specifications**

- **Weight:** 1.13kg (2.49 lbs).
- **Dimensions (H x W x D):** 1.65" (42mm) x 3.33" (84.5mm) x 10.2" (260mm).
- **Local Controls:** None.
- **Local Status and Alarm Indicators:**
  a. Power (Green)
  b. Protection (Yellow)
  c. Alarm (Red)

# Operation

## Local Indicators

**Location and Identification:** Refer to Figure 1.

**Description:** There are three (3) indicators located on the converter module's front panel. The functions of these indicators are as shown in Table 3.

***Note:*** *DC voltage must be present at the converter module output terminals (from battery or an operating converter module) or DC voltage at the input terminals.*

## Converter High Voltage Shutdown and Lockout Restart

**PROCEDURE**

Remove the converter, wait 30 seconds or more (until the LEDs on the converter extinguish), then re-insert the converter.

The converter(s) can also be restarted from the ACU+ LCD or WEB Interface menu (via the Over Volt Reset command, found in the Manual menu in the LCD menus or under the Converter Control Tab in the WEB Interface).

## Converter Current Limit

When setting total converter current limit, the set point to each converter is the total set point divided by the number of converters. For example, if the system contains five converters and the current limit is set to 150 amps then each converter has a current limit set point of 30 amps. If one or more converters are removed or fail it will take several seconds for the individual set points to the remaining converters to be reset. In the example given, if one converter is removed the current limit set point will drop to 120 amps (30 amps times four remaining converters) until the controller can send updated set points to the remaining converters. This takes a couple communication cycles (several seconds) after which each converter would have a new set point of 37.5 amps for a total of 150 amps. The total current limit of the converters should not be set such that the loss of the redundant converters will cause this temporary set point to drop below the actual maximum expected load.

*Figure 1. Local Indicator Locations*

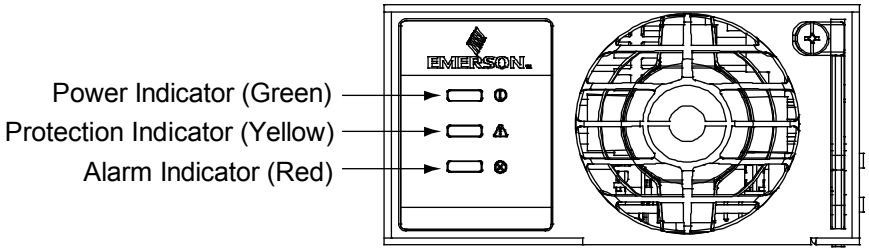



*Table 3. DC-DC Converter Module Indicators*

| Indicator | | Normal State | Alarm State | Alarm Cause |
|---|---|---|---|---|
| ⏻ | Power (Green) | On | Off | No input voltage.<br>Internal input fuse open. |
| | | | Flashing | The converter module is being identified by the Controller. |
| ⚠ | Protection (Yellow) | Off | On | DC input under/over voltage.<br>High temperature.<br>Moderate load sharing imbalance. |
| | | | Flashing | Loss of communication with the Controller (the converter can provide power). |
| ⊗ | Alarm (Red) | Off | On | Severe load sharing imbalance.<br>converter module output disabled for any reason, including overvoltage shutdown. |
| | | | Flashing | Faulty fan (converter module shuts down). |

## *Installing Converter Modules*

Converter modules can be inserted or removed with power applied (hot swappable).

***Note:*** *Each converter module locks into a module mounting shelf by means of a latch located on the bottom of the module. The latch and converter module handle are interactive. Pushing the handle up into the module's front panel causes the latch to extend to the locking position; pulling the handle down out from the module's front panel causes the latch to retract. See Figure 2.*

**CAUTION!** This converter module contains Double pole/Neutral fusing; parts of the equipment that remain energized might represent a hazard during servicing after operation of the fuse.

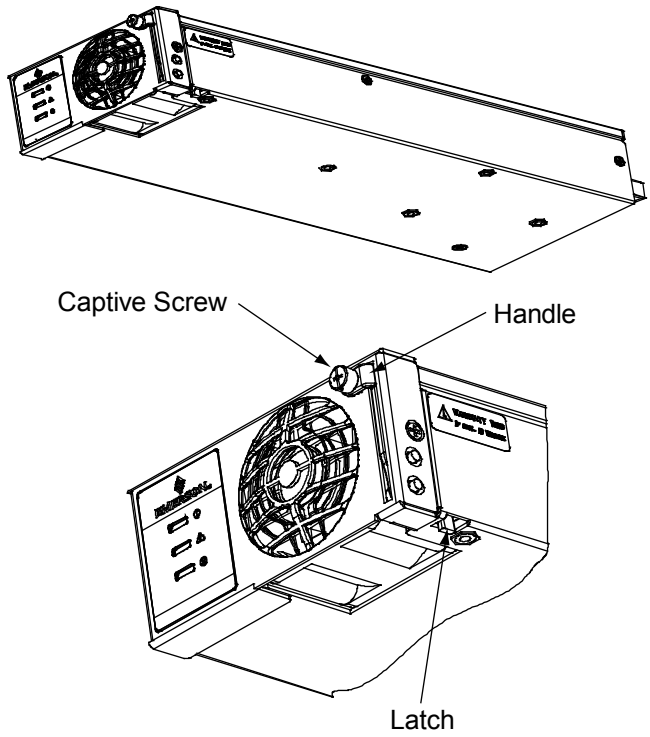
**WARNING!** To prevent damage to the latching mechanism, ensure the handle is in the open position when installing or removing a converter module. NEVER hold the handle in the closed position when installing a converter module into a shelf.

**PROCEDURE**

***Note:*** *Refer to Figure 2 as this procedure is performed.*

1. Unpack the module.
2. Place the module into an unoccupied mounting slot without sliding it in completely.
3. Loosen the captive screw on the module's handle. Pull the handle down out from the module's front panel (this will also retract the latch mechanism). See Figure 2.
4. Push the module completely into the shelf.
5. Push the handle up into the module's front panel. This will lock the module securely to the shelf. Tighten the captive screw on the handle.
6. Repeat the above steps for each converter module being installed in the system.
7. After the converter modules are physically installed in the mounting shelf(s), they are ready for operation immediately after power is supplied to them.
8. Certain functions (i.e. converter current limit, converter addressing) may require adjustment when adding or replacing a converter module. Refer to "Converter Current Limit" on page 4 and the Power System documentation for instructions.

*Figure 2. Installing Converter Module*




# Troubleshooting and Repair

## *Troubleshooting*

**Converter Module Current Sharing Imbalanced**

When multiple converter modules are operating in parallel and the load is greater than 10%, if the current sharing imbalance among them is greater than 2A, check if the converter module is properly seated in the shelf.

If the current sharing imbalance still persists following the verification suggested above, replace the converter module exhibiting the current imbalance.

### Converter Module Fault Symptoms and Troubleshooting

The fault indicators that can be displayed by the converter module are as follows.
Refer to Table 4 for a list of possible causes and corrective actions.

- Power Indicator (Green) OFF
- Protection Indicator (Yellow) ON
- Protection Indicator (Yellow) Flashing
- Alarm Indicator (Red) ON
- Alarm Indicator (Red) Flashing

*Table 4. Converter Module Troubleshooting*

| Symptom | | Possible Cause(s) | Suggested Action(s) |
|---|---|---|---|
| | **Power Indicator (Green) Off** | No input voltage. | Make sure there is input voltage. |
| | | Internal input fuse open. | Replace the converter module. |
| | **Protection Indicator (Yellow) On** | DC input voltage outside the normal range. | Correct the DC input voltage to within the acceptable range. |
| | | Moderate load sharing imbalance. | Check if the converter module is properly seated in the shelf. If this does not correct the fault, replace the converter module. |
| | | Converter module not inserted into the slot completely. | Remove and properly insert the converter module. |
| | | Converter module over-temperature protection, which could be caused by: | |
| | | 1. Fan rotor blocked. | 1. Remove any object that may be blocking the fan. |
| | | 2. Ventilation blocked (inlet or outlet). | 2. Remove any object that may be blocking the inlet or outlet. |
| | | 3. Ambient temperature too high or converter module inlet too close to a heat source. | 3. Lower the ambient temperature or relocate the heat source. |
| | **Protection Indicator (Yellow) Flashing** | Converter module communication failure. | Check the communication cables.<br>Remove and properly insert the converter module. |
| | **Alarm Indicator (Red) On** | Output over-voltage shutdown. Severe load sharing imbalance. | Remove the converter module from its shelf and then reinstall after 30 seconds. If converter module fails to start or shuts down again; replace the converter module. |
| | | Converter module addresses contradictory. | Replace the converter module. |
| | **Alarm Indicator (Red) Flashing** | Fan not operating (converter module shuts down). | Replace the converter module. |

## Replacement Procedures

### Converter Module Replacement

Converter modules can be inserted or removed with power applied (hot swappable).

***Note:*** *Each converter module locks into a module mounting shelf by means of a latch located on the bottom of the module. The latch and converter module handle are interactive. Pushing the handle up into the module's front panel causes the latch to extend to the locking position; pulling the handle down out from the module's front panel causes the latch to retract. See Figure 2.*

**DANGER!** Take care when removing a converter module that was in operation, as converter module surfaces could be very hot.

**WARNING!** To prevent damage to the latching mechanism, ensure the handle is in the open position when installing or removing a converter module. NEVER hold the handle in the closed position when installing a converter module into a shelf.

**PROCEDURE**

***Note:*** *Refer to Figure 2 as this procedure is performed.*

1. Performing this procedure may activate external alarms. Do one of the following. If possible, disable these alarms. If these alarms cannot be easily disabled, notify the appropriate personnel to disregard any alarms associated with this system while this procedure is performed.
2. Loosen the captive screw on the module's handle. Pull the handle down out from the module's front panel (this will also retract the latch mechanism). See Figure 2.
3. Grasp the handle and pull firmly to remove the module from the shelf.
4. Place the replacement converter module into the mounting position without sliding it in completely.
5. Loosen the captive screw on the module's handle. Pull the handle down out from the module's front panel (this will also retract the latch mechanism). See Figure 2.
6. Push the module completely into the shelf.
7. Push the handle up into the module's front panel. This will lock the module securely to the shelf. Tighten the captive screw on the handle.
8. Certain functions (i.e. converter current limit, converter addressing) may require adjustment when adding or replacing a converter module. Refer to "Converter Current Limit" on page 4 and the Power System documentation for instructions.
9. After the converter modules are physically installed in the mounting shelf(s), they are ready for operation immediately after power is supplied to them. Verify that the converters are operating normally.
10. Enable the external alarms, or notify appropriate personnel that this procedure is finished.
11. Ensure that there are no local or remote alarms active on the system.

# NetSure™ DC/DC Converter Module

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